A Novel Optimum Technique for JPEG 2000 Post Compression Rate Distortion Algorithm

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***Abstract*—The new technique we proposed in this paper based on Hidden Markov Model in the field of post compression rate distortion algorithms certainly meet the requirements of high quality still images. The existing technology has been extensively applied in modern image processing. Development of image compression algorithms is becoming increasingly important for obtaining a more informative image from several source images captured by different modes of imaging systems or multiple sensors. The JPEG 2000 image compression standard is very sensitive to errors. The JPEG2000 system provides scalability with respect to quality, resolution and color component in the transfer of images. But some of the applications need certainly qualitative images at the output ends. In our architecture the Proto-object also introduced as the input ant bit rate allocation and rate distortion has been discussed for the output image with high resolution. In this paper, we have also discussed our novel response dependent condensation image compression which has given scope to go for this post compression Rate Distortion Algorithm (PCRD) of JPEG 2000 standard. This proposed technique outperforms the existing methods in terms of increasing efficiency, optimum PSNR values at different bpp levels. The proposed technique involves Hidden Markov Model to meet the requirements for higher scalability and also to increase the memory storage capacity.**

***Index Terms*—JPEG 2000, Hidden Markov Model, Rate distortion, Scalability, Image compression, post compression**

I. Introduction

JPEG 2000 is a new digital imaging system that builds on JPEG but differs from it. It utilizes a Wavelet transform and an arithmetic coding scheme to achieve scalability in its design and operation. It offers improved compression, better quality for a given file size under most circumstances. This is especially true at very high compression. As a result a greater emphasis is being placed on the design of new and efficient image coders for voice communication and transmission. Today applications of image coding and compression have become very numerous. Many applications involve the real time coding of image signals, for use in mobile satellite communications, cellular telephony, and audio for videophones or video teleconferencing systems. The recently developed Post compression Rate Distortion Algorithms for JPEG 2000 standard 2000 standard, which incorporates wavelet at the core of their technique, provides many excellent features compared to the other algorithms. From the time David Taubman introduced Post compression Rate Distortion Algorithms for JPEG 2000 in terms of scalability, many algorithms have been forced into various fields of applications. The Discrete Wavelet Transform coding (DWT) is the widely used transform technique in JPEG 2000 applications. The applications require some improvements in scalability, efficiency, memory storage capacity.So; we proposed Hidden Markov Model technique in this paper to JPEG 2000 still image compression standard. The outline of the paper is as follows. Section II about the background of the proposed technique which involves overview of JPEG 2000 and Response Dependent Condensation Image Compression Algorithm. Section III describes about the Methodology of the architecture. Section IV gives simulation results of our work. Conclusion appears in Section V.

II. BACKGROUND

A. Overview of JPEG2000

The JPEG 2000 has Superior low bit-rate performance at all bit rates was considered desirable, improved performance at low bit-rates, with respect to JPEG, was considered to be an important requirement for JPEG2000. Seamless compression of image components each from 1 to 16 bits deep, was desired from one unified compression architecture. Progressive transmission is highly desirable when receiving imagery over slow communication links. Code-stream organizations which are progressive by pixel accuracy and quality improve the quality of decoded imagery as more data are received. Code-stream organizations which are progressive by “resolution” increase the resolution, or size, of the decoded imagery as more data are received. [19].Both lossless and lossy compression was desired, again from single compression architecture. It was desired to achieve lossless compression in the natural course of progressive decoding. JPEG 2000 is also having other salient features such as code stream accessing random manner, processing, robustness to bit-errors and sequential build-up capability. Due to this the JPEG 2000 is having the quality to allow for encoding of an image from top to bottom in a sequential fashion without the need to buffer in an entire image. This is very useful for low memory implementations in scan-based systems. [19] In the JPEG2000 core coding system, the sample data transformations, sample data coding, rate-distortion optimization, and code stream reorganization. The first sample data transformations stage compacts the energy of the image through the Discrete Wavelet Transform (DWT), and sets

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the range of image samples. Then, the image is logically partitioned into code locks that are independently coded by the sample data coding stage, also called Tier-1. [21]

B. Response Dependent Condensation Algorithm

Our Response Dependent Condensation Image Compression Algorithm is to develop an array error packing addressing methodology from original image and error image and it depends on the application. The compression ratios of different transforms have observed. To calculate compression ratio, a 2-dimensional 8X8 image was considered. First image is converted into binary format then it is processed. The output is also binary format and it is given to MATLAB to reconstruct the output. The simulation results using the hybrid transform has given better results compared to other transformation techniques(DCT-Discrete Cosine Transform, DFT- Discrete Fourier Transform, DST-Discrete Sine Transform, DWT- Discrete Walsh Transform, DHT- Discrete Hartley Transform).Wavelet analysis is capable of revealing aspects of data that other signal analysis techniques such as Fourier analysis miss aspects like trends, breakdown points, discontinuities in higher derivatives, and self-similarity. [22] The component transform provides de-correlation among image components (R, G, and B). This improves the compression and allows for visually relevant quantization. When the reversible path is used, the Reversible Component Transform (RCT) is used, which maps integers to integers. When the irreversible path is used the YCbCr transform is used as is common with the original JPEG 2000. [22] The dynamic condensation matrix is response dependent and the corresponding condensation is referred as Response-Dependent Condensation. The dynamic condensation matrix is defined as the relations of an eigenvector between the input and output. This novel approach of studying linear effects in JPEG 2000 compression of color images. The DCT has been performed on the bench mark figures and each element in each block of the image is then quantized using a quantization matrix of quality level 50. At this point many of the elements become zeroed out, and the images takes up much less space to store. The image can now be decompressed using proposed algorithm. At quality level 50 there is almost no visible loss in this image, but there is high compression. At lower quality levels, the quality goes down by a lot, but the compression does not increase very much. Similarly, experiments are also conducted to various images to find out the compression. The Response Dependent Compression Algorithm is applied to calculate the image compression. It can be observed that noise is slightly removed but there is a huge change in image dimensions. Response Dependent Compression Algorithm is applied to calculate the image compression. It can be observed that noise is slightly removed but there is a huge change in image dimensions. This response dependent condensation algorithm gives better results compared to other transformation techniques. Our algorithm which discussed about the gives an idea and scope to move further for proto-object segmentation with reference to the scalability by replacing the basic Discrete Wavelet Transform(DWT) with other waveform techniques including present technique Hidden Markov Model (HMM) for certain applications involving still images.

III. METHODOLOGY OF PROPOSED ARCHITECTURE

A. Hidden Markov Model

Hidden Markov Model (HMM)is the technique we are using in our proposed work as it is best suitable for image processing techniques mainly segmentation and compression. The standard formula for estimating the model according to the rate distortion and bit rate allocation can be derived from our architecture To segment an image, the bit rate allocation that is in terms of pixel to pixels of the Proto-image we are giving as the input image handled easily with HMM. The problems in our work can be handled by HMM as it is suitable for smoothing and statistical significance. The probability that a sequence drawn from some null distribution will have an HMM probability in the case of the forward algorithm or a maximum state sequence probability at least as large as that of a particular output sequence. If a HMM is used to evaluate the relevance of a hypothesis for a particular output sequence, [25] the statistical significance indicates the false positive rate associated with accepting the hypothesis for the output sequence.

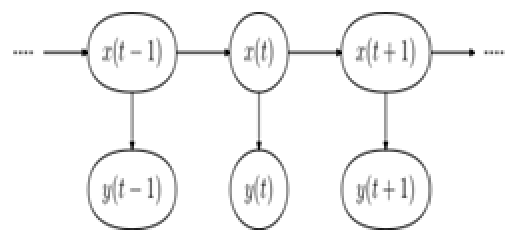

Figure 1.Architecture of Hidden Markov Model

The task is to compute, given the parameters of the model and a particular output sequence up to time t, the probability distribution over hidden states for a point in time in the past. To compute the forward-backward algorithm is an efficient method for computing the smoothed values for all hidden state variables and Hidden Markov Model can represent even

$$P(x(k) \mid y(1), \ldots, y(t)) \qquad \text{for } k < t \ldots (1)$$

more complex behavior when the output of the states is represented as mixture of two or more Gaussians, in which case the probability of generating an observation is the product of the probability of first selecting one of the Gaussians and the probability of generating that observation from that Gaussian. This is the reason for choosing the Hidden Markov Model for our proposed work. The proposed architecture block diagram of our work is described in this section as follows.The block diagram of our proposed architecture with reference to the paper mentioned in [23].

B. Scalability

The high buffering cost of embedded compression is unavoidable so long as we insist on generating the embedded bit-stream in order. An alternate approach, however, is to process the image or sub band samples locally while

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producing the embedded bit-steam prior to a final reorganization step can be significantly smaller than the image itself, assuming that compression is achieved for constructing embedded bit-streams[19]

C. PCRD Coding and Pre-coding stages

*According to the g*eneral derived PCRD algorithm of David Taubman and Marcellin describes algorithm which may be used to optimize the set of code-block truncation points, $\{z_i\}$, so as to minimize the overall distortion, D, subject to an overall length constraint, L_{max}.The same algorithm may be used to minimize the overall length subject to a distortion constraint if desired. We refer to this optimization strategy as post-compression rate-distortion optimization (PCRD-opt). The algorithm is implemented by the compressor, which is expected to computer or estimate length and distortion contributions, $L_i^{(z)}$ and $D_i^{(z)}$, for each truncation point, z = o,1,…., Z_i. Tis information will not normally be explicitly included in the pack-stream. As a result, the algorithm is not easily reapplied to a previously constructed pack-stream.. as a result, the algorithm is not easily reapplied to a previously constructed pack-stream may contain many quality layers. [19] Input image into PO regions and BG regions, and then reconsider both the construction of an operational RD curve in the coding pipeline and the implementation of an efficient rate control scheme in terms of PO regions. By using PO region segmentation instead of tile partition, defining the quality layer in terms of PO regions.
By assuming overall distortion is additive

$$D = \sum_{i=1}^{N} D_i(n_i). \qquad \ldots\ldots\ldots..(1)$$

It is desired to find the optimal selection of bit stream truncation points n_i such that the overall distortion metric is minimized subject to a constraint.[24]

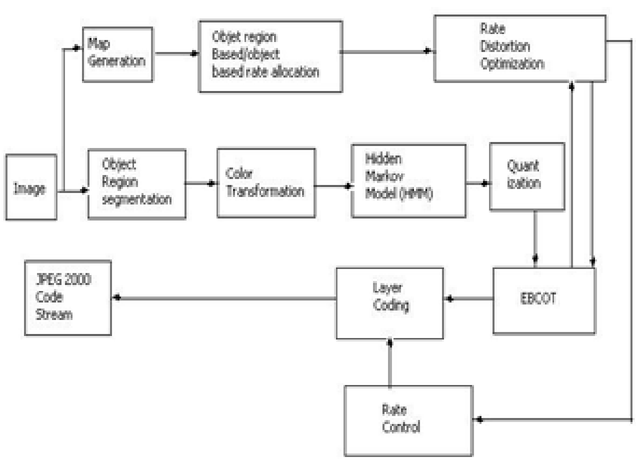

Figure.2.Blockdiagram of the Proposed Architecture

$$R^{max} \geq R = \sum_i R_i(n_i). \qquad \ldots..(2)$$

These are reflected in the partition system and coding pipeline of the JPEG2000 system.[23] In the coding stage the operational RD curve is constructed in two steps: 1) the Tier-1 output code-stream segments with a set of truncation points for coding passes. The code-stream segment is the smallest unit for constructing the operational RD curve. 2) Quality layers of PO regions are developed in Tier-2, and this forms the final operational curve for the further purpose of rate control.[23]. Similarly in the post-coding stage, by using the actual RD functions of all the compressed data, the optimal truncation techniques attain the minimum image distortion for a given bit rate. Our rate control scheme is based on the estimation of RD slopes of the coding passes. Using these estimations, the selection of coding passes to yield a target bit rate can be performed without information related to the encoding process, or distortion measures based on the original image. [23]. The Quality scalability is achieved by dividing the wavelet transformed image into code-blocks. After that each code-block is encoded, a post-processing operation determines the each code-block's embedded stream should be truncated in order to achieve a pre-defined bit-rate or distortion bound for the whole image. This bit-stream rescheduling module is referred to as the Tier 2. It establishes a multi-layered representation of the final bit-stream, guaranteeing an optimal performance at several bit rates or resolutions. [24]

D. EBCOT Block

The coding and ordering techniques adopted by JPEG2000 are based on the concept of Embedded Block Coding with Optimal Truncation (EBCOT), which is the subject of this chapter. Each sub band is partitioned into relatively small blocks).Division of sub bands into code-blocks, having the same dimensions in every subband. All sub bands are depicted with the size and the code-blocks appear to have different sizes of code-blocks. Each code-black, B_i, is coded independently, producing an elementary embedded bit-stream, C_i. Although any prefix of length, L_i, should represent an efficient compression of the block's samples at the corresponding rate.

E. Quantization

The trade-off between rate and distortion is obtained by quantization. Wavelet coefficients can be divided by a different value for each sub-band. Alternatively, portions of the coded data can be discarded. This discarding of data can be done in a variety of creative ways. The proposed technique was implemented on several bench mark figures like Lena, River, House, Animal, River and also several sample figures including color and black/white images and observed that the results we got are comparably better.

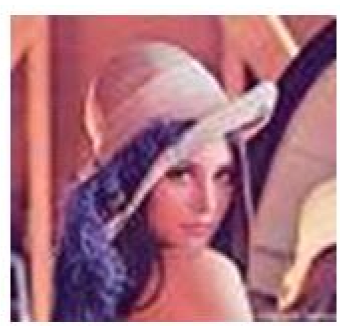

Fig.3.USID benchmark (Lena)

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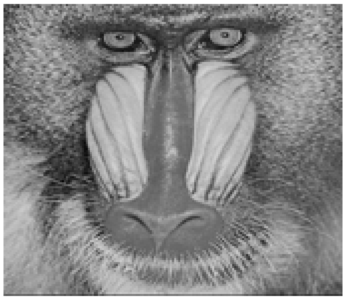

Fig.4.USID benchmark (Animal)

Fig.5.USID benchmark (River)

Fig.6.USID benchmark (House)

IV. SIMULATION RESULTS

The MATLAB used as the simulation tool to prove the better results on the bench mark figures such as Lena, River, House ,Animal , River and also several sample figures including color and black and white images to the existing Algorithms.

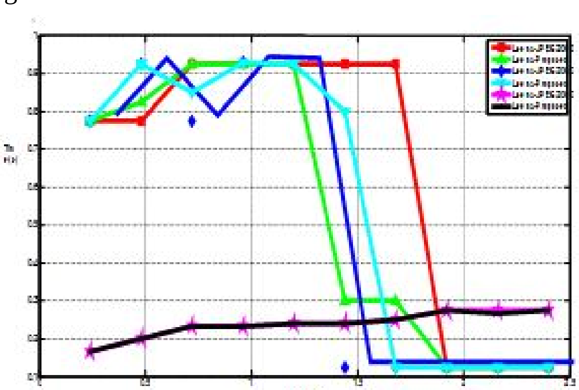

Figure 7. Comparison of bpp Vs time

TABLE I. BPP VERSUS COMPUTATION TIMES

Sample No	bpp	Computation time (s)
1	0.25	0.782
2	0.5	0.835
3	0.75	0.915
4	1.0	0.925
5	1.5	0.945

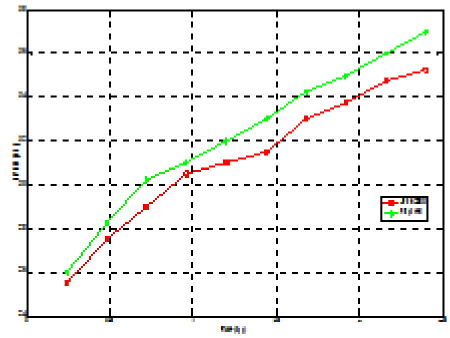

Figure 8. Comparison of performance

TABLE II. BPP VERSUS PSNR

Sample No	bpp	PSNR (dB)
1	0.25	26
2	0.5	28.5
3	0.75	30.25
4	1.0	31.15
5	1.5	33.75

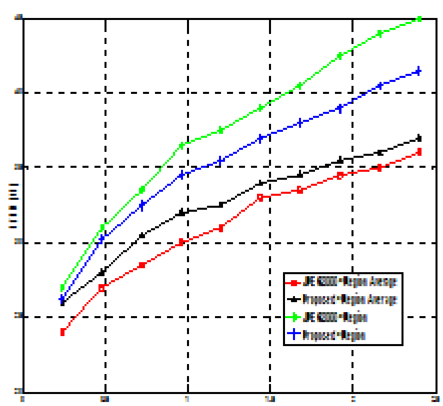

Figure 9. Comparison of bpp versus PSNR

The experimental values from the tables I, II and III clearly shows that the new technique proposed in this paper has better values with respect to computation times, PSNR values at various bpp values. The complexity has been reduced by applying Hidden Markov Model in place of the other wavelet

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transforms like DWT. In the post compression process the rate distortion and bit rate allocation will generally play a major role in various application requirements. This technique can also utilized to perform the object region coding and segmentation processing of different types of application images for different applications.

TAVLE III. BPP VERSUS PSNR

Sample No	bpp	PSNR (dB)
1	0.25	26.25
2	0.5	30.25
3	0.75	33.15
4	1.0	34.675
5	1.5	37.515

This is for the mobile, remote sensing, still image compression related applications. The JPEG image compression systems can be affected by soft errors because of their wide uses in remote sensing and medical imaging. In such applications, fault tolerance techniques are very important in detecting computer induced errors within the JPEG compression system, thus guaranteeing the quality of image output while employing the compression data format of the standard. Fault tolerance is different from error resilience in compression standards. Resilience generally refers to the capabilities of recovering from errors introduced by the transmission path of compressed data while fault tolerance protects against errors that are introduced by the computing resources executing the compressing and decompressing algorithms. Scalability is an important concept of JPEG2000 still image compression standard. The JPEG2000 codec is transform based, and resolution scalability is a direct consequence of the multi-resolution properties of the Discrete Wavelet Transform (DWT). A code stream is said to be resolution scalable if it contains identifiable subsets that represent successively lower resolution versions of the original image. Since bi-level images are invariably digitized at high resolutions, this property of the code-stream is potentially very useful. Consider the case where high resolution images are being viewed by a user over a network. Typically, the image at full resolution will be too large to display on the user's monitor. By making use of the inherent scalability of the JPEG2000 code stream, it is possible to stream only the relevant portions of the image to the client. This allows JPEG2000 content to be delivered in a manner which matches the user's display resolution.[26][27] In JPEG2000, both the reversible and irreversible transforms can be implemented using a common lifting framework. In a broad sense, lifting provides a means to generate invertible mappings between sequences of numbers, and the invertibility is unaffected even when arbitrary operators, which may be linear or non-linear, are introduced in the lifting steps [26][27].This flexibility allows the use of non-linear rounding operations in the lifting steps, in order to ensure that the transform coefficients are integers. In this paper we have discussed about the necessity of enhanced scalability for various applications. For better results the images were tested for different resolutions like512x512, 256 x256.

CONCLUSIONS

This paper proposes new technique in the field of Post compression Rate Distortion Algorithms for JPEG 2000 with Hidden Markov Model technique which outperforms the other existing methods in terms of scalability. It also showed better results in PSNR versus bpp and the computational complexity has been reduced considerably which increases the efficiency and memory storage capacity.

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